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FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT

CD NO.

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COUNTRY	USSR	DATE OF INFORMATION	1948
SUBJECT	Scientific - Chemical industry		
HOW PUBLISHED	Book	DATE DIST.	15 Mar 1950
WHERE PUBLISHED	Moscow	NO. OF PAGES	9
DATE PUBLISHED	1948		
LANGUAGE	Russian	SUPPLEMENT TO REPORT NO.	

THIS IS UNEVALUATED INFORMATION

SOURCE Tekhnologiya Gidroliznogo Proizvodstva, V. A. Smirnov, 1948.

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REPORT ON V. A. SMIRNOV'S "TECHNOLOGY OF THE (WOOD, CELLULOSE, AND VEGETABLE MATERIAL) HYDROLYSIS INDUSTRY"

/Figures are appended./

This book was published by Pishchepromizdat (Food Industries Publishing House), Moscow, 1948; 364 pp, 13 roubles. Circulation of this edition was 5,000. Authorized by the Ministry of Higher Education USSR for use as a textbook in higher educational institutions in the field of food and nutrition.

The title of this book and the fact that it has been published as a manual for the food industry are somewhat misleading. While sugar, one of the main products of the industry in question, is traditionally a good product the industry has developed considerably since the principal and only product of the hydrolysis of sawmill waste was food sugar. The raw material is no longer wood or cellulose exclusively--hence, the new term "hydrolysis industry."

A considerable quantity of the sugar obtained by hydrolysis is fermented to alcohol and the alcohol obtained in this manner is used as the principal raw material for production of synthetic rubber in the USSR. Alcohol is also being used to an increasing extent as motor fuel in the USSR, and so alcohol rather than sugar is regarded as the more important product of the hydrolysis industry.

At present the Russian hydrolysis industry, which has the highest capacity in the world, is slated for expansion mainly because of the high demand for technical alcohol. In accordance with the postwar Five-Year Plan, the production of hydrolysis alcohol in 1950 will be eight times higher than before the war. This involves the construction of new plants having a production capacity of 7 million decaliters. In connection with this production, all byproducts will be utilized in conformity with the principle of total conversion, which is being applied at present. Total conversion, i.e., complete industrial utilization of all byproducts, is typical of the Russian hydrolysis industry and presupposes a rather high level of technological development in this field. A general scheme for conversion of conifer wood, which is the principal raw material at present, is shown in Figure 1.

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In connection with the construction of large plants that will utilize cotton hulls, the conversion of vegetable raw material (agricultural wastes, etc.) having a higher pentosan content is expected to become of increasing importance. A scheme for utilization of material rich in pentosan is outlined in Figure 2. The lignin gas generator fuel listed on both appended charts i dried by using the waste heat of power plant furnace gases. The final product (pressed lignin) is regarded as an excellent fuel for transport gas generato..s, but some lignin is burned on the spot at the lower plants attached to the installations where it is produced.

The Russian hydrolysis industry has a long history and tradition. The first attempts to produce edible sugar from starch date back to the 18th Century and hydrolysis of wood, cellulose, and straw was carried out early in the 19th Century. By analogy with the standard procedure for the hydrolysis of starch, sulphuric acid was originally used for the hydrolysis of wood and cellulose. The sulphuric acid method still remains the principal process used in Russia and has been developed to a considerable extent from the practical and engineering standpoint since the early beginning of the industry. The use of sulphuric acid is a distinguishing mark of the Russian hydrolysis industry and denotes a development largely independent of that which has taken place abroad.

Hydrolysis with concentrated sulphuric acid was quickly abandoned because of the difficulty of recovering the acid and dilute sulphuric acid was used instead. The weaker action of dilute sulphuric acid and other difficulties resulted in the fact that only hemicelluloses were hydrolyzed in the first semicommercial installation built in 1898 for the hydrolysis of wood. It took a long time before the process in its final form, involving the use of dilute sulphuric acid was mastered.

From 1920 - 1930, research on the hydrolysis of wood was intensified. Gradual hydrolysis of the same batch in the same autoclave with several successive portions of fresh acid doubled the yield of sugar, bringing it up to 38-42 percent of the weight of wood. From this, the percolation hydrolysis, first proposed by Iroshkina in 1920, was developed. The so-called pulsating hydrolysis, which involves rapid changes of temperature and pressure with a resulting effect somewhat similar to that occuring in the popping of corn, was developed next. This brought the yield of sugar up to 50 percent of the weight of dry wood with a sugar concentration of 3 percent in the hydrolysate and an expenditure of 100 percent sulphuric acid corresponding to 26-27 percent of the weight of sugar.

Systematic research on various methods and pilot-plant work were started in 1934, when experimental plants in Cherepovets (saw dust), Arkhangelsk (saw dust), and Verkhnedneprovsk (straw and other agricultural wastes) were built. The so-called gradual diffusion method based on the counter-current principle and involving circulation through several autoclaves was developed then. This procedure lowered the yield to 36 percent, due to the longer time during which the sugar stayed in solution, and raised the sugar concentration in the hydrolyzate to 4 percent. This method was never applied practically because of the excessive complexity of operation. The spraying of hot acid into an autoclave the charge of which had been heated to 180-185°C has been found to be of advantage, however, mainly because the useful volume of the autoclave (6 cubic meters) could be increased many times over that used in the pulsation method. Constant steam pressure is maintained in the autoclave. More efficient heat recovery from the hydrolyzate is possible. On completion of the hydrolysis, and prior to recharging the autoclave, the spent charge, which had been washed with hot water, is blown with steam into a cyclone. The average concentration of the hydrolyzate is approximately 3 percent and the yield of sugar about 45 percent.

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The use of sulphuric acid has certain advantages over that of hydrochloric acid. For instance, the hydrolyzate can be evaporated without neutralizing the acid (using the heat of the hydrolyzate) and furfural, turpentine, and methanol can be recovered from the vapor during the process. Neutralization is carried out with calcium hydroxide. After calcium sulphate has been filtered off, the solution, up on addition of superphosphate and ammonium sulphate, is an excellent growth medium for yeast. On the other hand, hydrolchloric acid, although a superior hydrolysis catalyst, must be neutralized with sodium hydroxide, as a result of which the presence of Nations would interfere with the activity of yeast. (One can neutralize with calcium hydroxide, of course, but the presence of calcium chloride presumably would have a still more deleterious effect on yeast). Hydrogen chloride cannot be removed by evaporation and some of it must be neutralized, but removal of the remainder of acid by means of ion exchange agents is conceivable.

Notwithstanding the emphasis on the production of a hydrolyzate, which can be fermented to alcohol easily and efficiently, hydrolysis with hydrochloric acid has also received close attention from Russian technologists, and considerable work on the subject has been done. The advantages of using highly concentrated hydrochloric acid (41-42 percent HCl) rather than dilute acid, which consist in the possibility of using low temperatures and drastically reducing the consumption of steam, have been realized.

Basing their work on foreign publications, which are regarded as incomplete, particularly the work of Bergius up to 1940, the Russians have further investigated the hydrochloric acid process from the point of view of complete utilization of byproducts. The production of crystalline dextrose, gas generator brickets, activated carbon, alcohol, and glycerine (the latter from impure sugar) can be accomplished on the basis of this process. Dextrose production from wood by the hydrochloric acid method is regarded as excessively complicated, however, and for that reason work on hydrolysis with concentrated sulphuric acid is being continued. The idea of combining the production of crystalline dextrose with that of phosphate fertilizers or ammonium sulphate, i.e., of reusing sulphuric acid after the hydrolysis for the decomposition of apatite or the synthesis of ammonium sulphate, seems to be of interest.

In the discussion of the hydrolysis industry, application of the products as fuels seems to be noteworthy. The use of gas generator lignin brickets has already been mentioned. In regard to the use of alcohol as a motor fuel, the author of the book makes the following comments. Alcohol is not used alone as a motor fuel, because the latent heat of evaporation is so high (205 kcal/kg for absolute alcohol as compared with 115 kcal/kg for gasoline) that heating of the air up to 100°C would be necessary. Notwithstanding the comparatively low boiling point (78.3°), the vapor pressure of alcohol at low temperatures is lower than that of gasoline, so that it is impossible to start a cold motor on alcohol.

However, by adding alcohol to gasoline the effectiveness of the latter as a fuel is improved. Notwithstanding the fact that alcohol has a lower combustion heat than gasoline, it is burned more completely and produces more heat than gasoline. Consequently, the efficiency of the motor is increased when alcohol is added to the gasoline. A gasoline-alcohol mixture is highly compressible and has very good antiknock properties.

A mixture of absolute alcohol with gasoline is very stable. Depending on the composition, the point of separation varies, but is lower than -40°C. If common alcohol of 95-96 percent C_2H_5OH content is admixed to the gasoline rather than absolute alcohol, separation into layers, especially at low temperatures, should be prevented by means of a stabilizer. As stabilizers, higher alcohols (7-10 percent by volume of the mixture of butyl alcohol, amyl alcohol, etc.), esters, or benzene are effective.

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In considering the relation of the hydrolysis industry to the petroleum industry, the use of furfural for the solvent treatment of lubricants must be mentioned. Furfural is also considered to be of great value in the USSR as a substituent for formaldehyde in the plastics industry, the latter aldehyde being in very short supply. Furfural replaces formaldehyde for use as a disinfectant and can be used as a preservative for fats and oils in the concentration of 1:1000.

The book is a manual which covers the technical aspects of an important industry. The following table of contents illustrates the scope of the book:

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Figure 1. General Scheme of the Total Conversion of Conifer Wood by the Method of Acid Hydrolysis

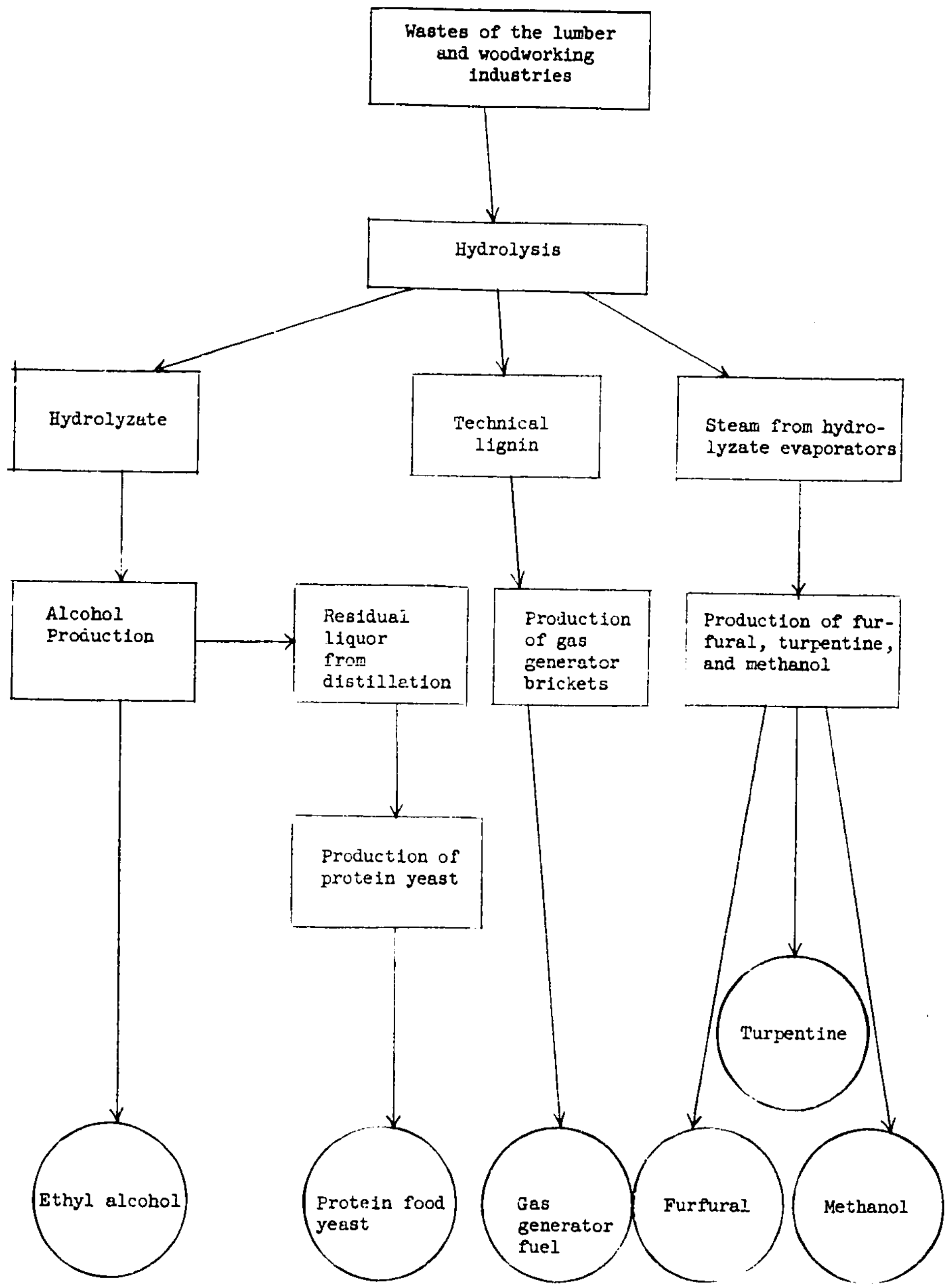

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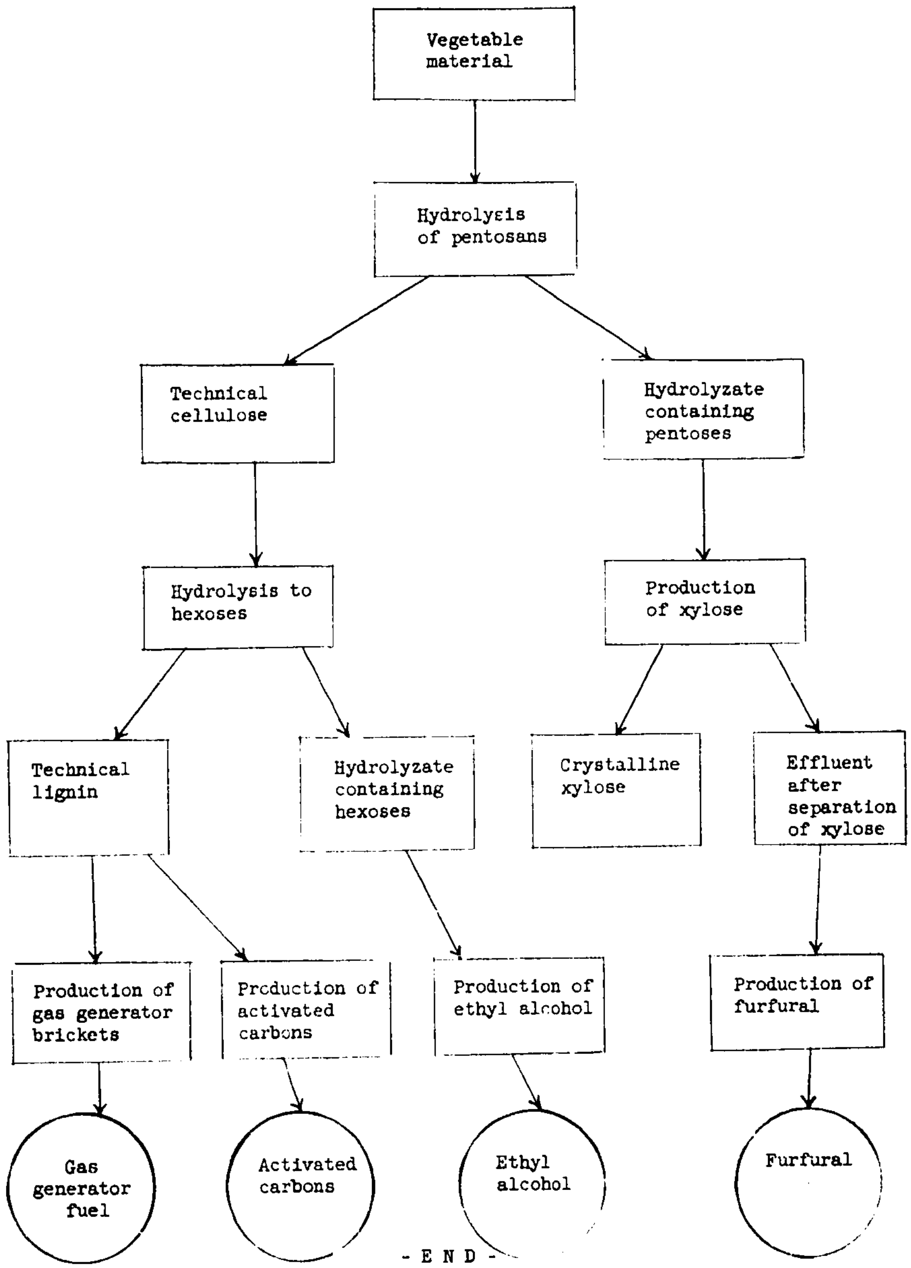
Figure 2. General Scheme of the Total Conversion of Agricultural Wastes of Vegetable Origin by the Method of Acid Hydrolysis



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